

# Blacktip-Atlantic Shark Assessment State-space, Age-structured Production Model

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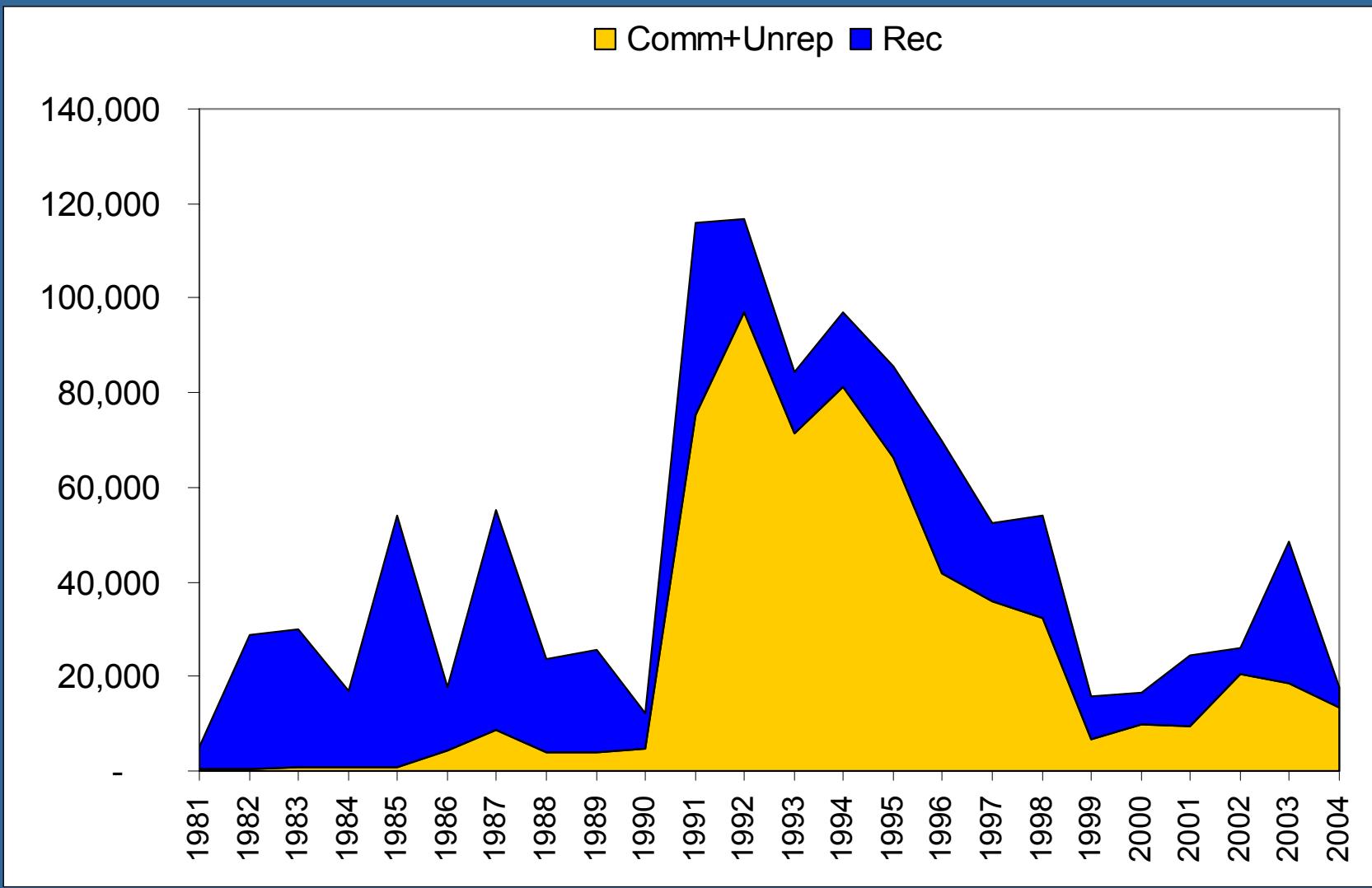
# OUTLINE

1. Data Inputs
  - a. Fishery
  - b. Biology
2. Model Description
3. Base Model and Results
4. Sensitivity Cases
5. Summary of all Results
6. Continuity case

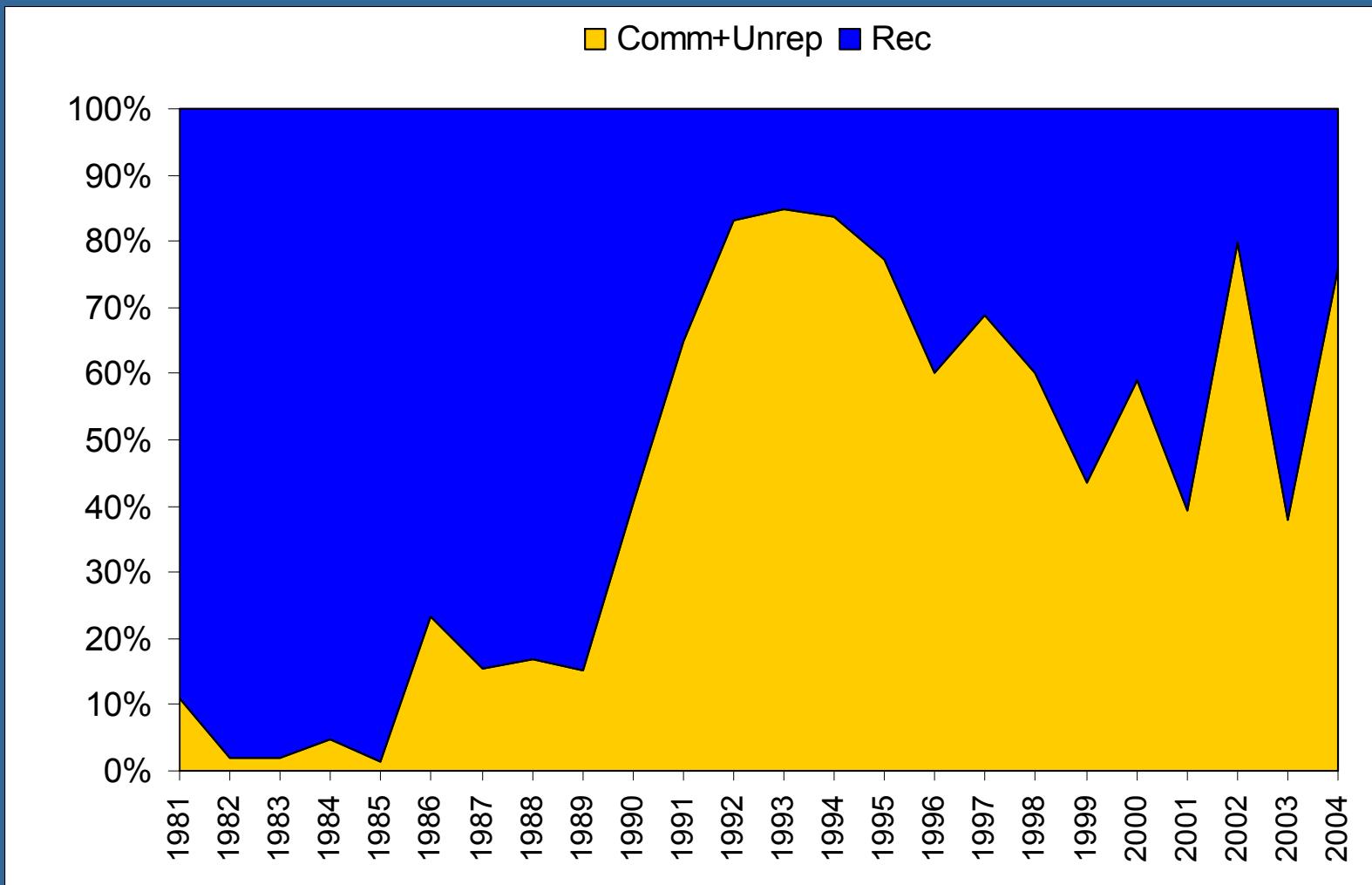
# 1a. Fishery Inputs

- Catch Series:
  - Commercial + Unreported Commercial
  - Recreational

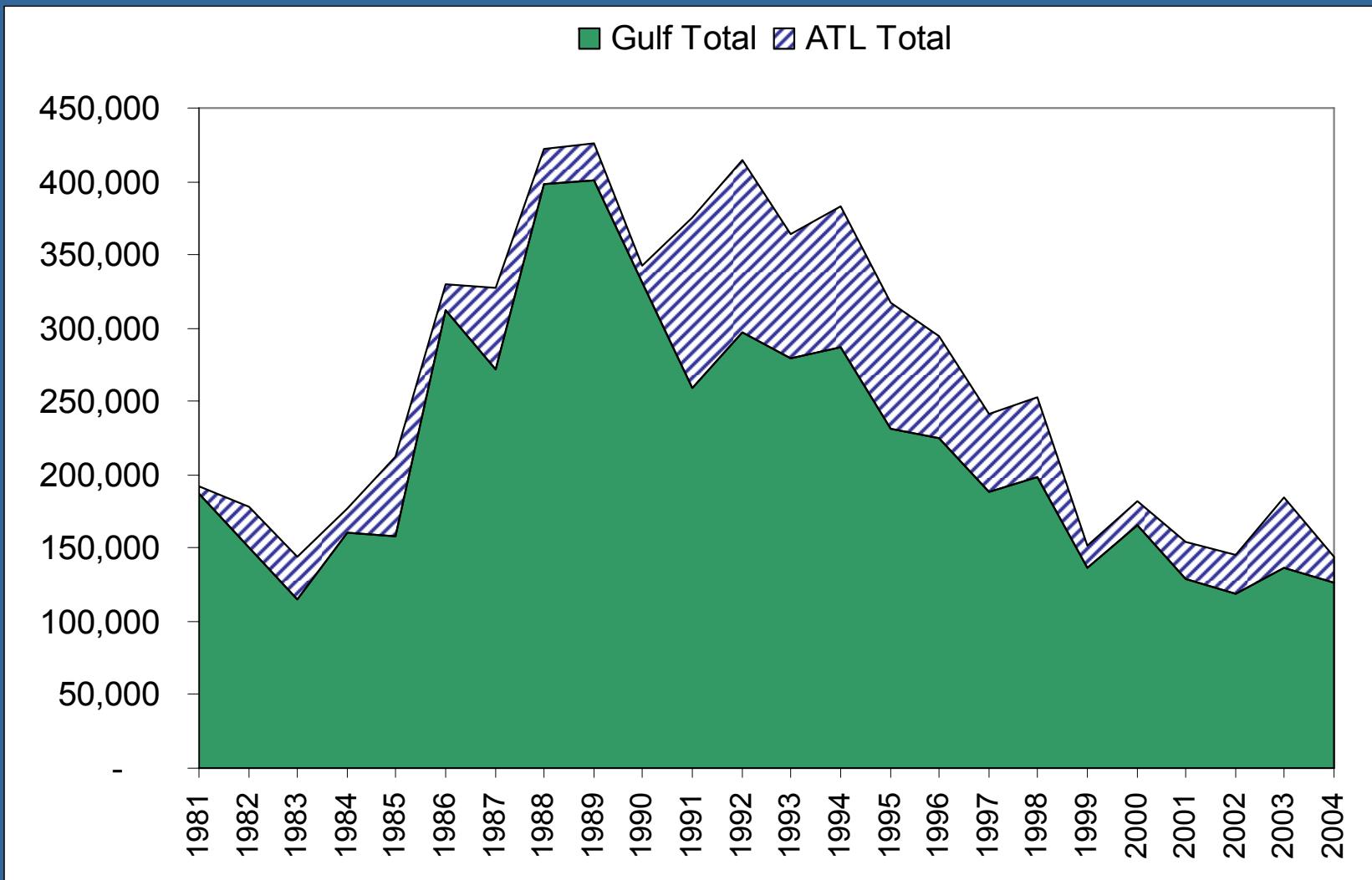
# Catches



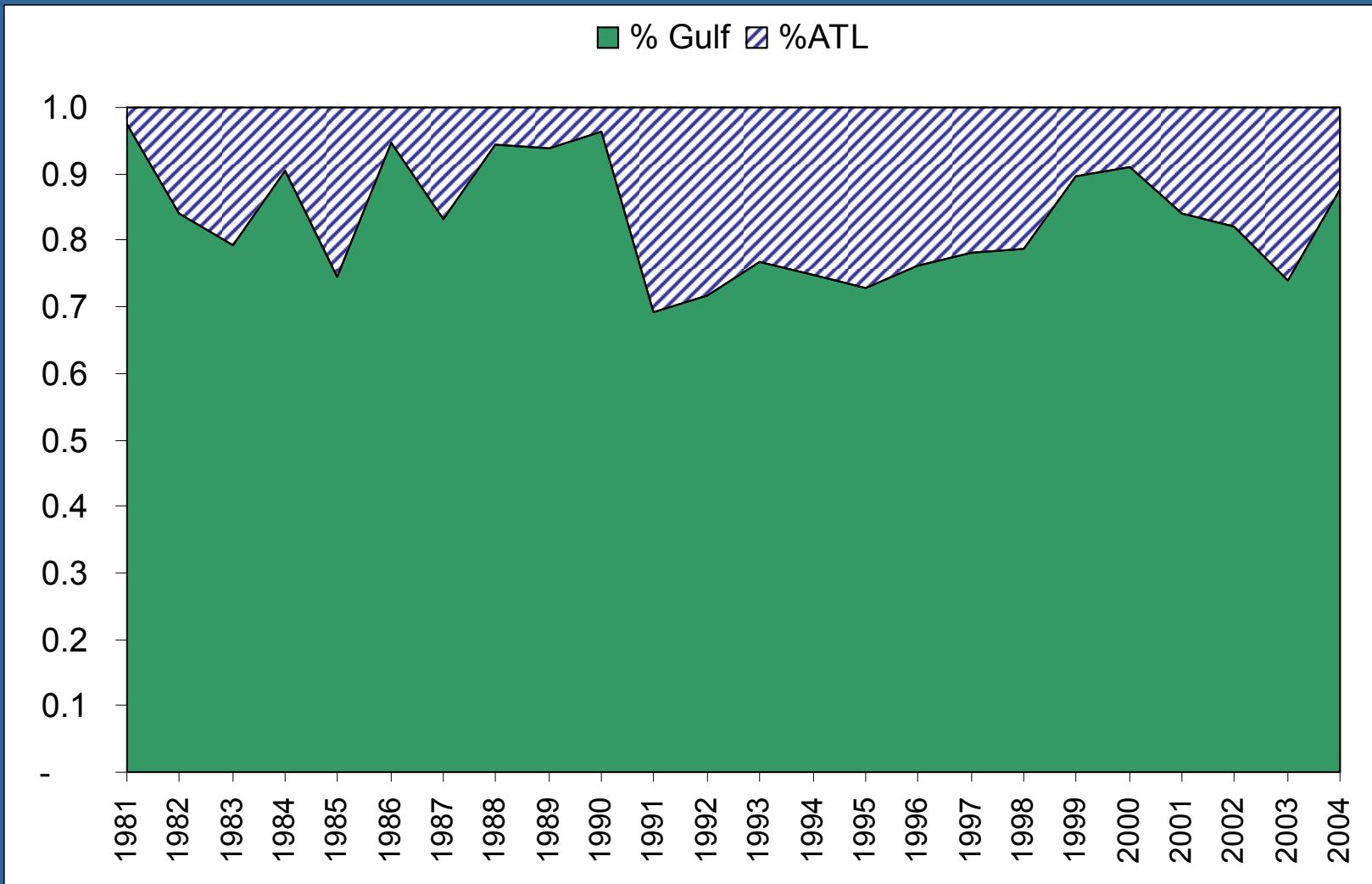
# Catches



# Catch by Stock



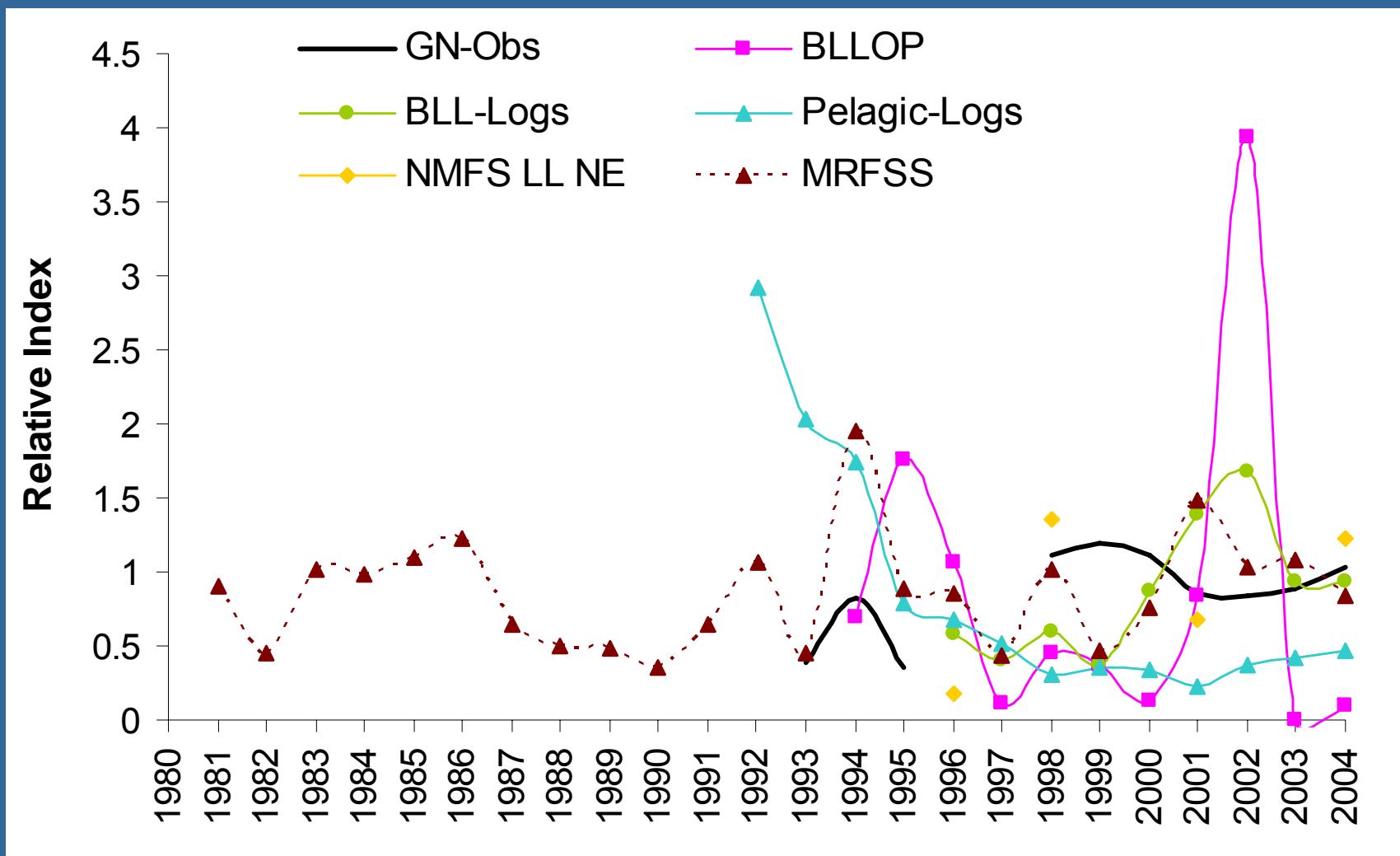
# Catch by Stock



# 1a. Fishery Inputs

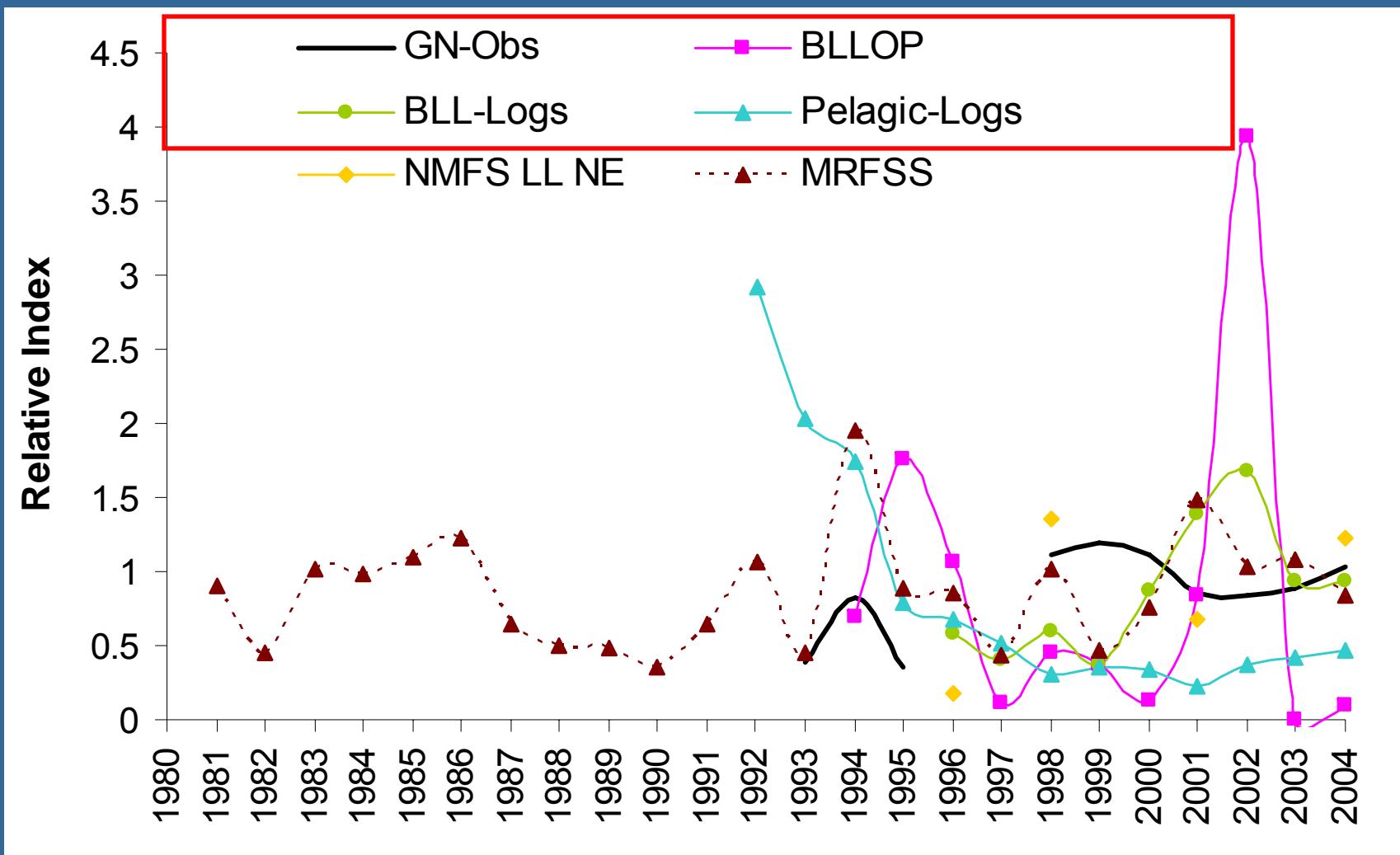
- Indices of Abundance:
  - BLLOP, NMFS LL NE, BLL Logs, Pelagic Log, GN Observer
  - MRFSS

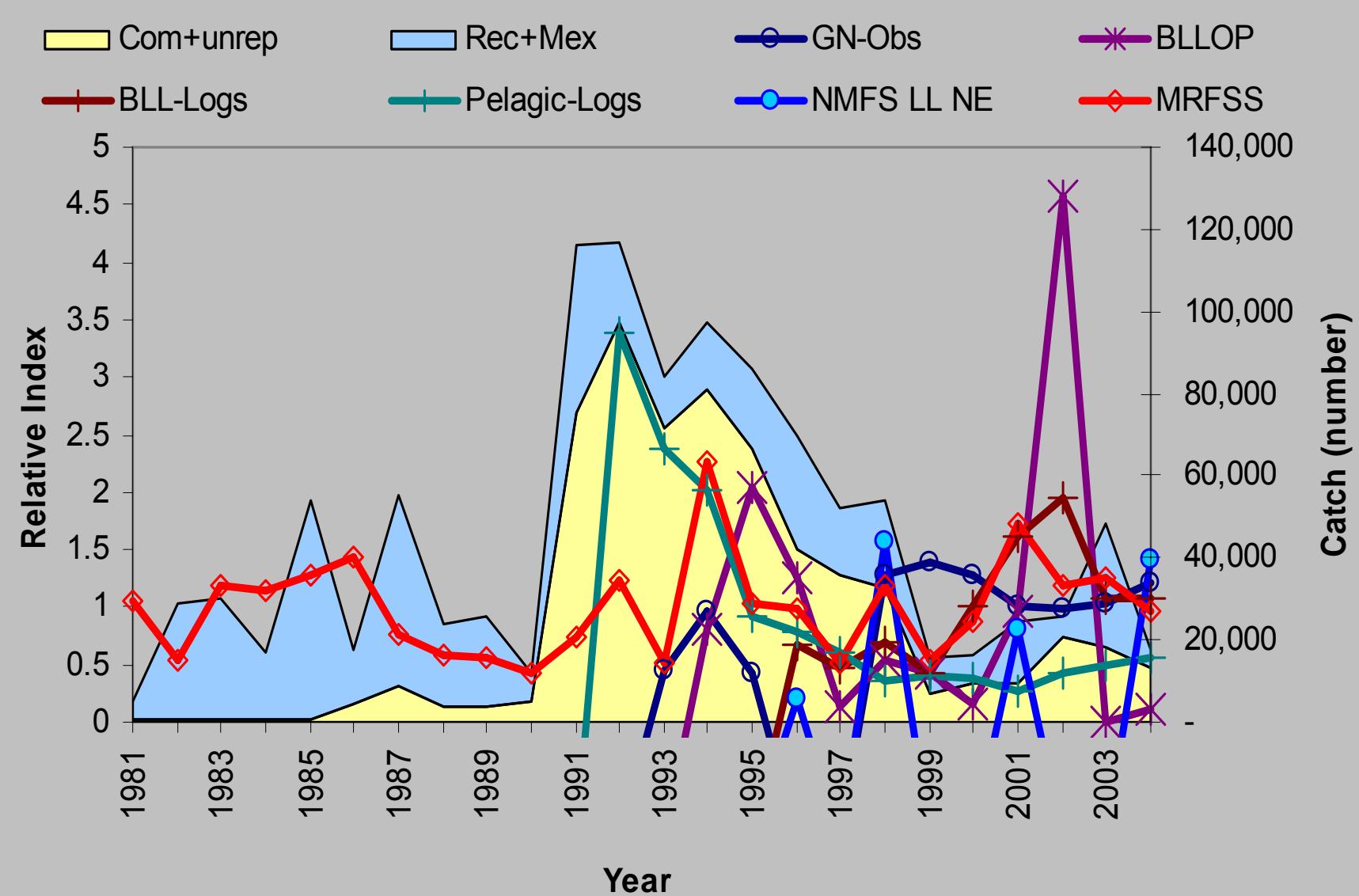
# INDICES



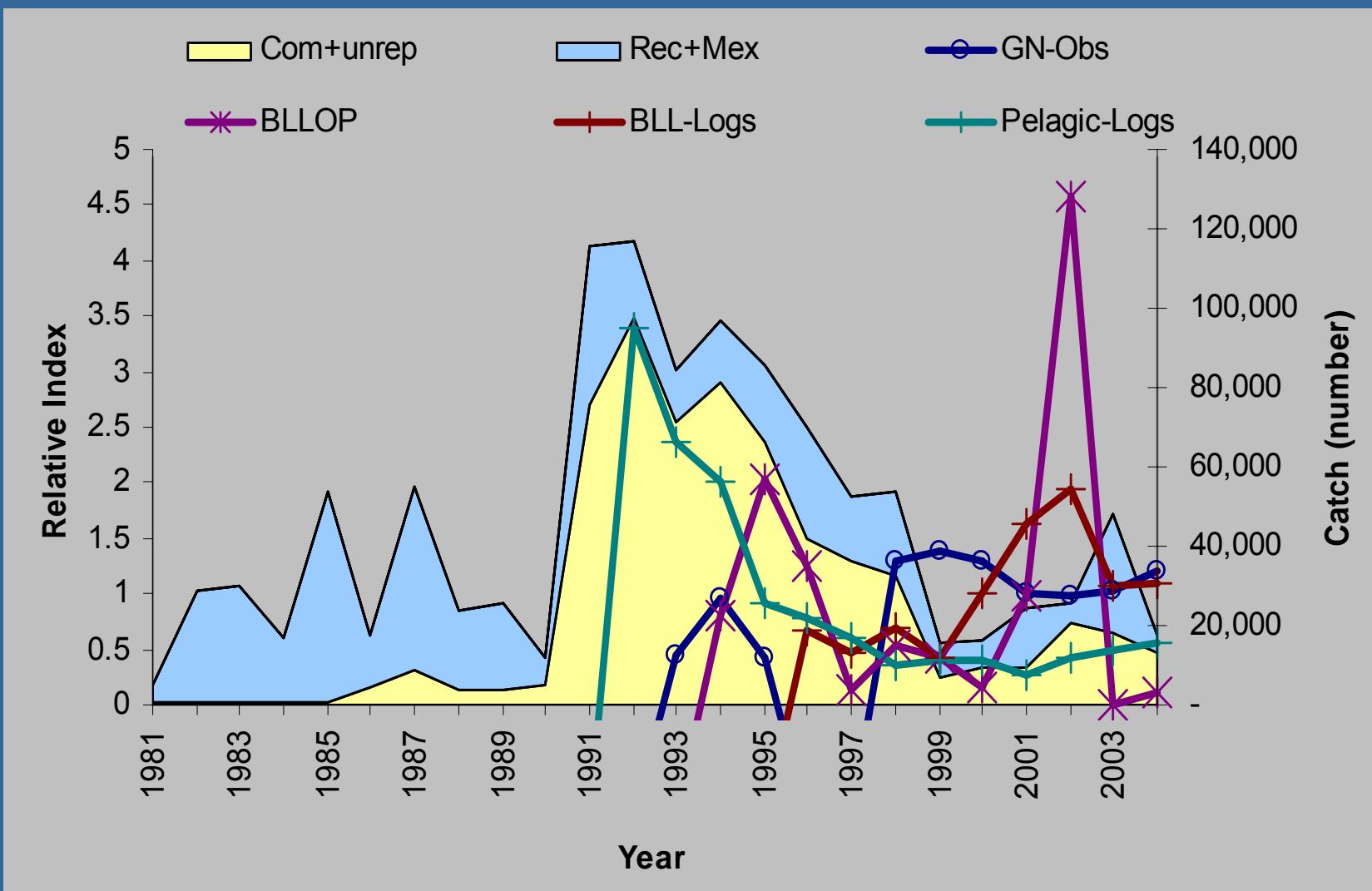
# INDICES

Base Indices



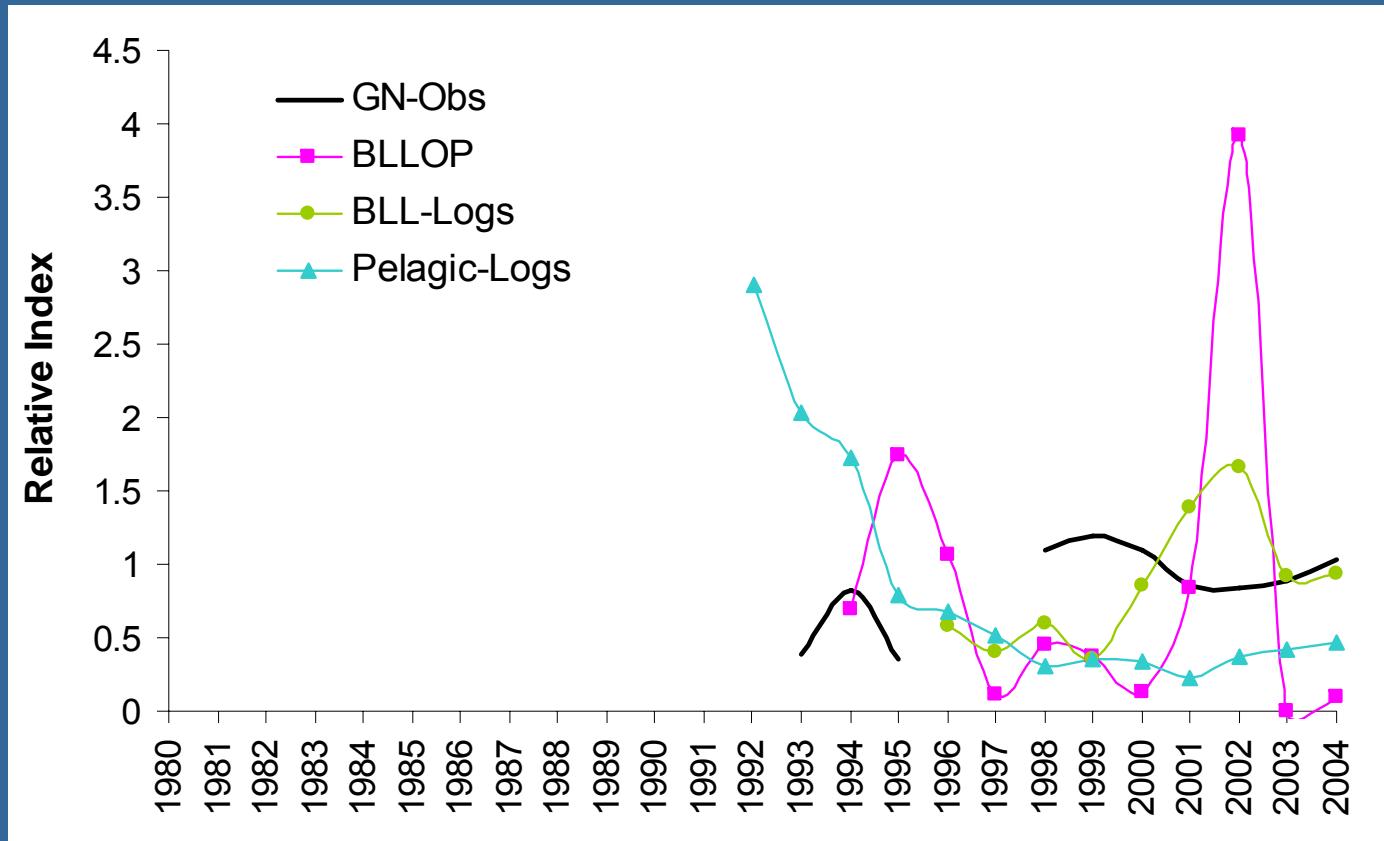


# Base case inputs



Ages 7+  
~ fully  
selected

## Indices with same selectivity



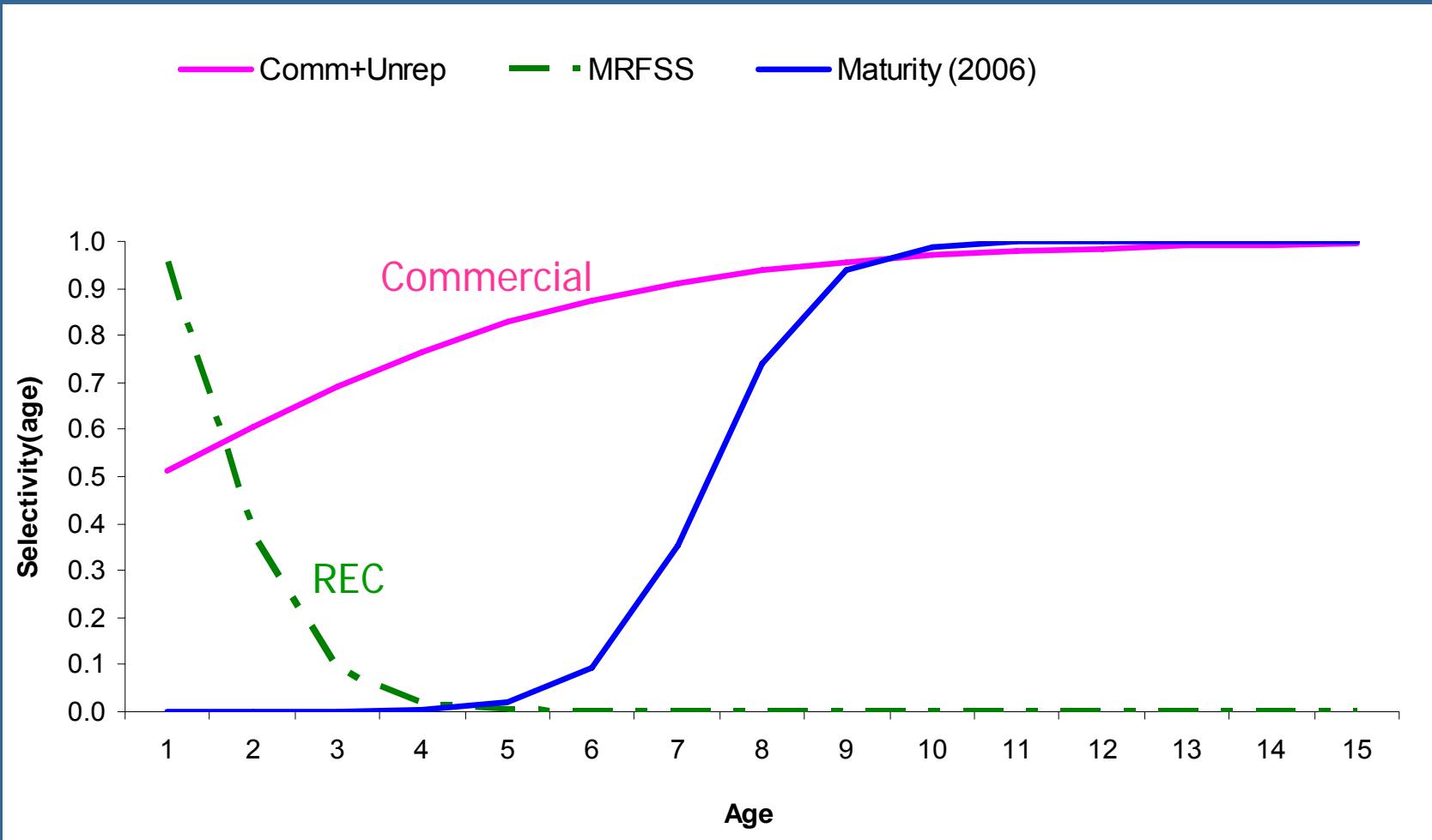
# 1a. Fishery Inputs

- Selectivity for catches:
  - Commercial + Unreported Commercial
  - Recreational

# Selectivity Derivations

- Selectivity reflects both vulnerability to gear as well as availability to fishery
- P89 of AW report and pp38-39 of DW report
- some length frequency data, info from 2002 assessment, collective knowledge of fisheries and participants at DW

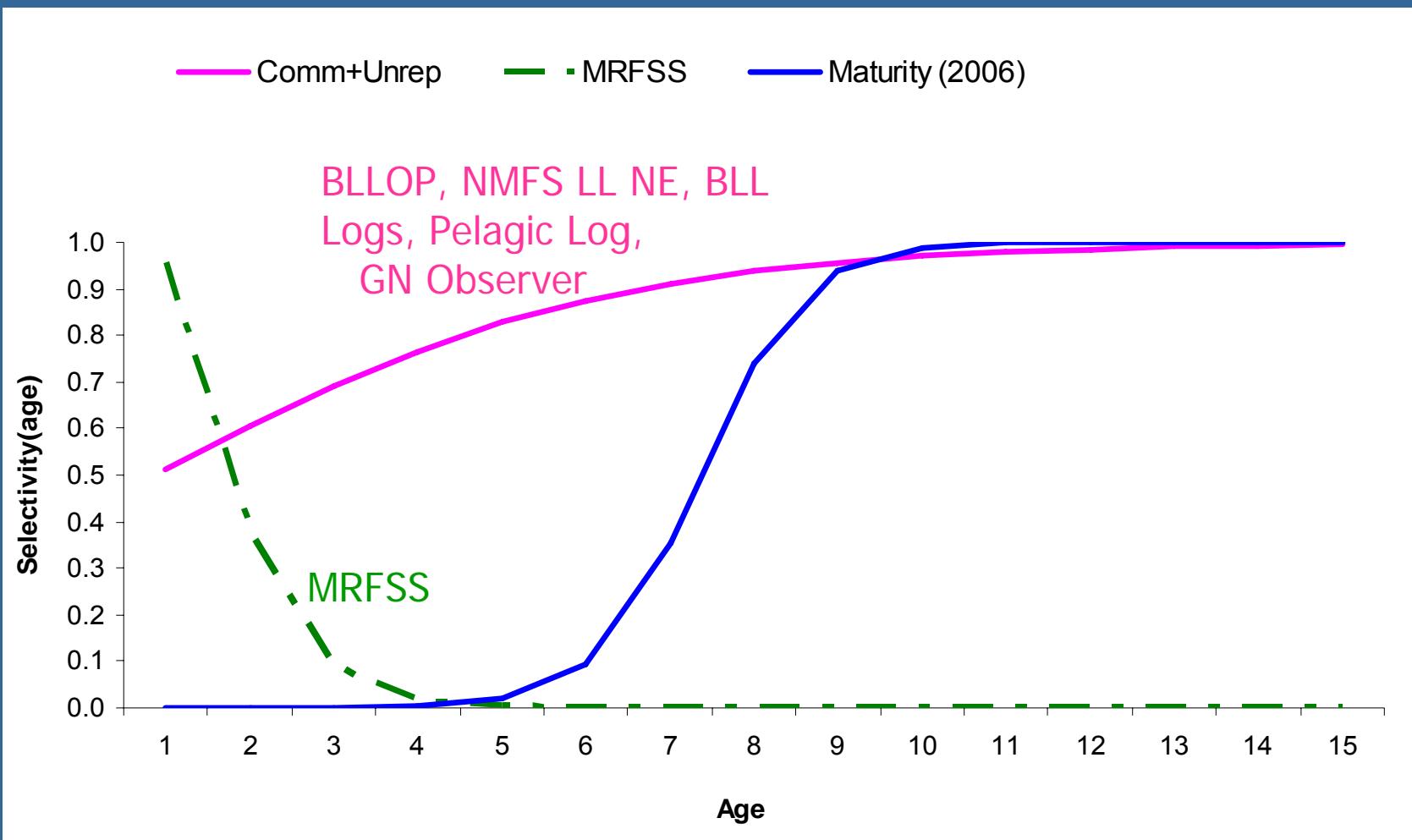
# Selectivity - Catch



# 1a. Fishery Inputs

- Selectivity for Indices:
  - BLLOP, NMFS LL NE, BLL Logs, Pelagic Log, GN Observer
  - MRFSS

# Selectivity - Indices



## 1b. Biological Inputs – DW values

- Pup-production: 3.2
- Natural Mortality: 0.29 → 0.16
- Pup-Survival: mode 0.52
- Maturity: ~ 50% age 7.5;  
~100% age 11
- Steepness: 0.2-0.5

# Steepness – Max. Repro Rate ( $\alpha$ )

- $\alpha = \text{pup.survival} \times \text{virgin.spawners.per.recruit}$

$$\alpha = \text{pup.survival} \times \varphi_0 = \sum_{age} fec_{age} \cdot mat_{age} \prod_{j=1}^{age-1} e^{-M_j}$$

- Steepness =  $\alpha / (\alpha+4)$

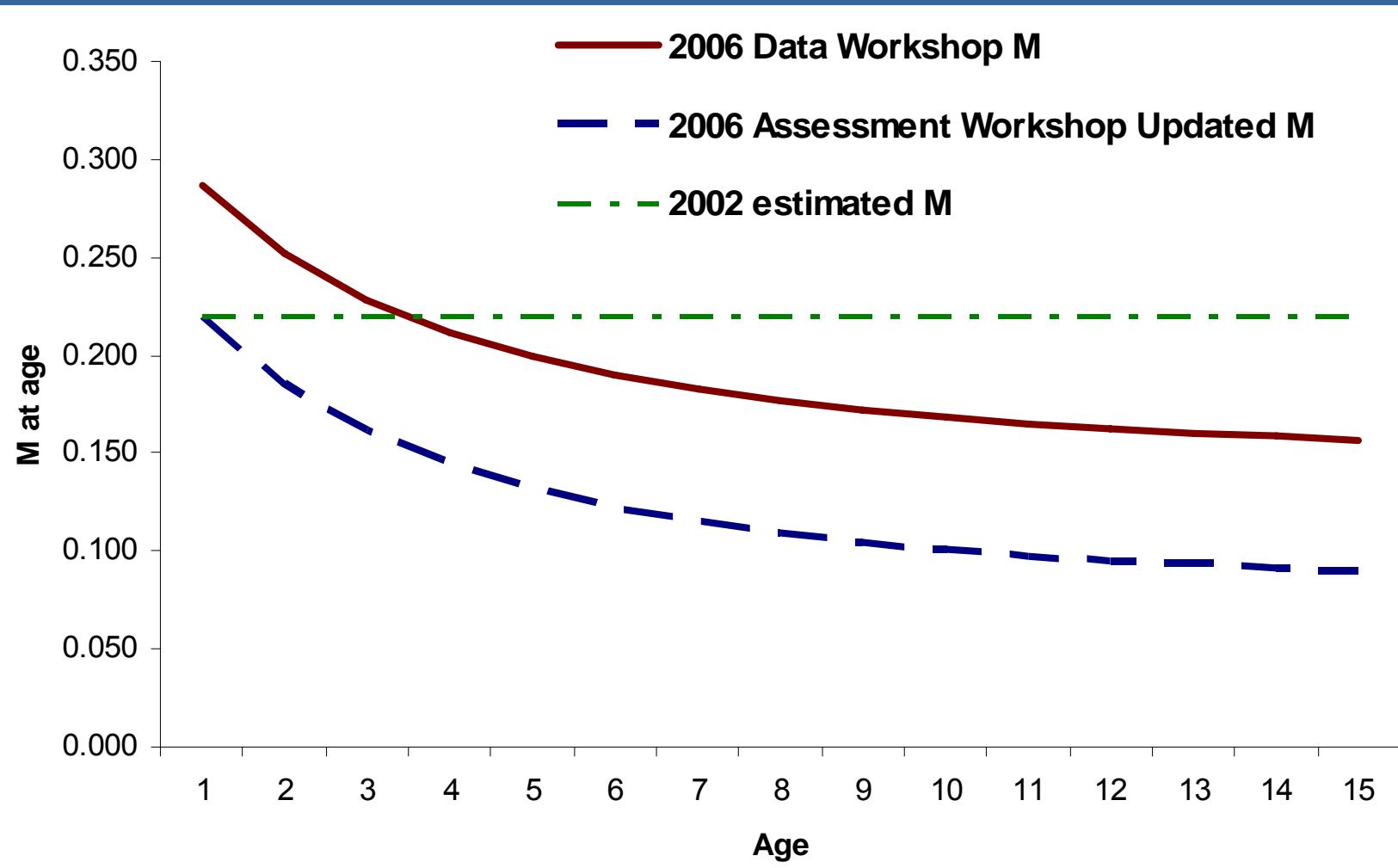
## 1b. Biological Inputs – DW values

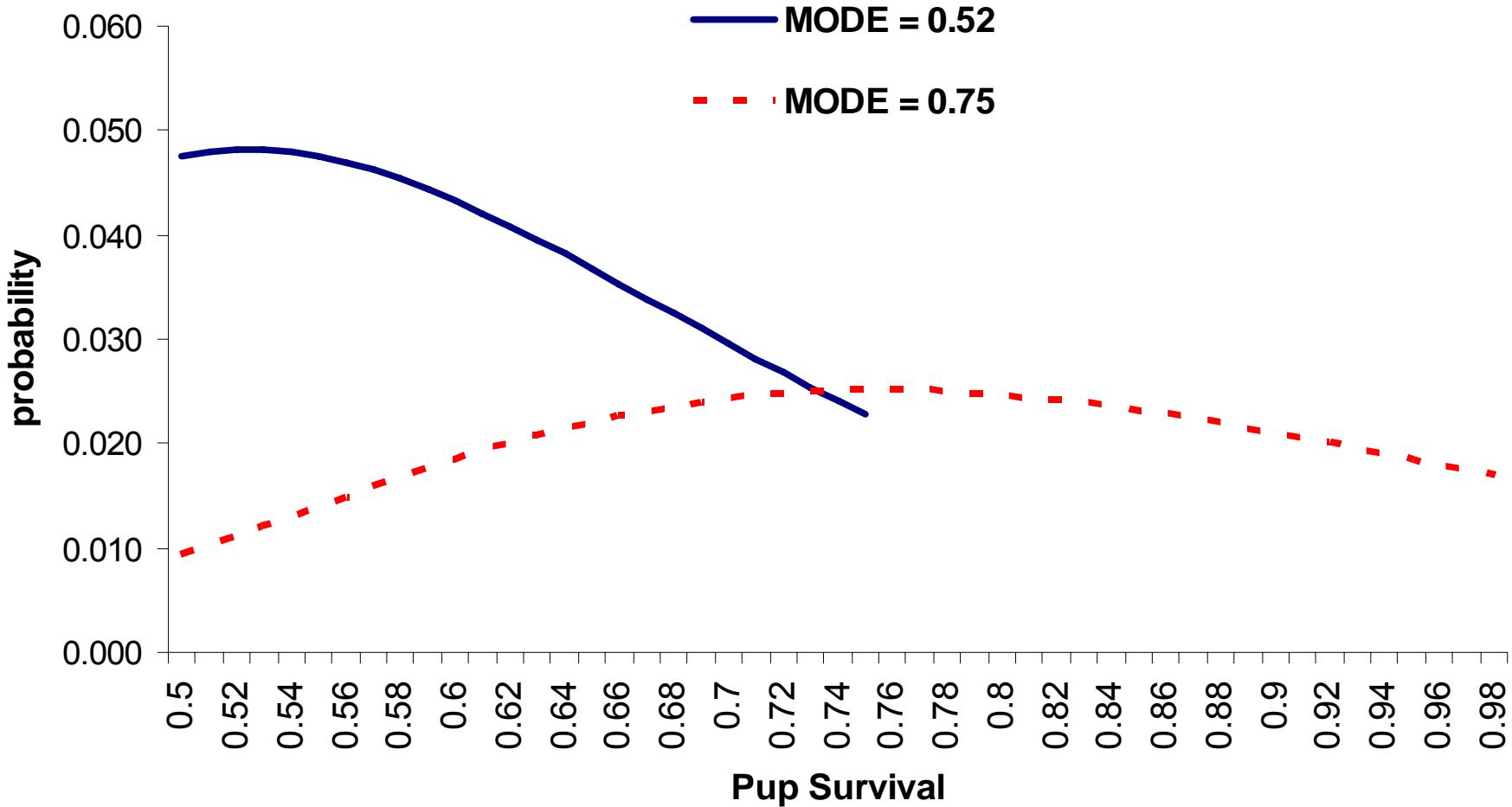
- Pup-production: 3.2
- Natural Mortality: 0.29 → 0.16
- Pup-Survival: mode 0.52
- Maturity: ~ 50% age 7.5;  
~100% age 11
- ~~Steepness: 0.2-0.5~~ 0.13  
**steepness only defined on [ 0.2 , 1.0 ]**

## 1b. Biological Inputs – AW updates

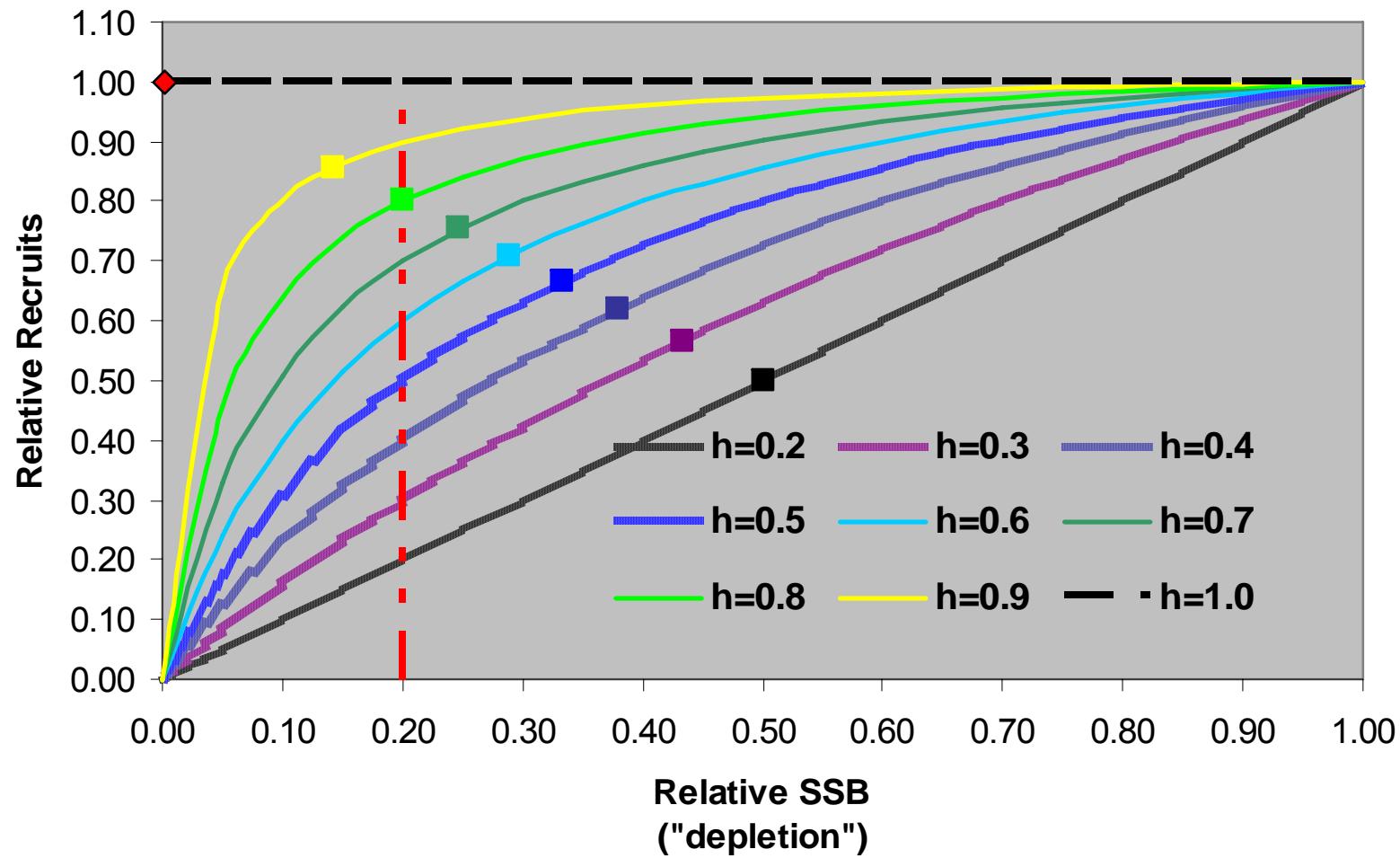
- Pup-production: 3.2
- Natural Mortality: 0.29 → 0.16 0.22 → 0.09
- Pup-Survival: mode 0.52                            0.75
- Maturity: ~ 50% age 7.5;  
    ~100% age 11
- Steepness: 0.2-0.5                                    0.37

NOTE: Same problem with steepness in 2002,  
but pup-production was increased

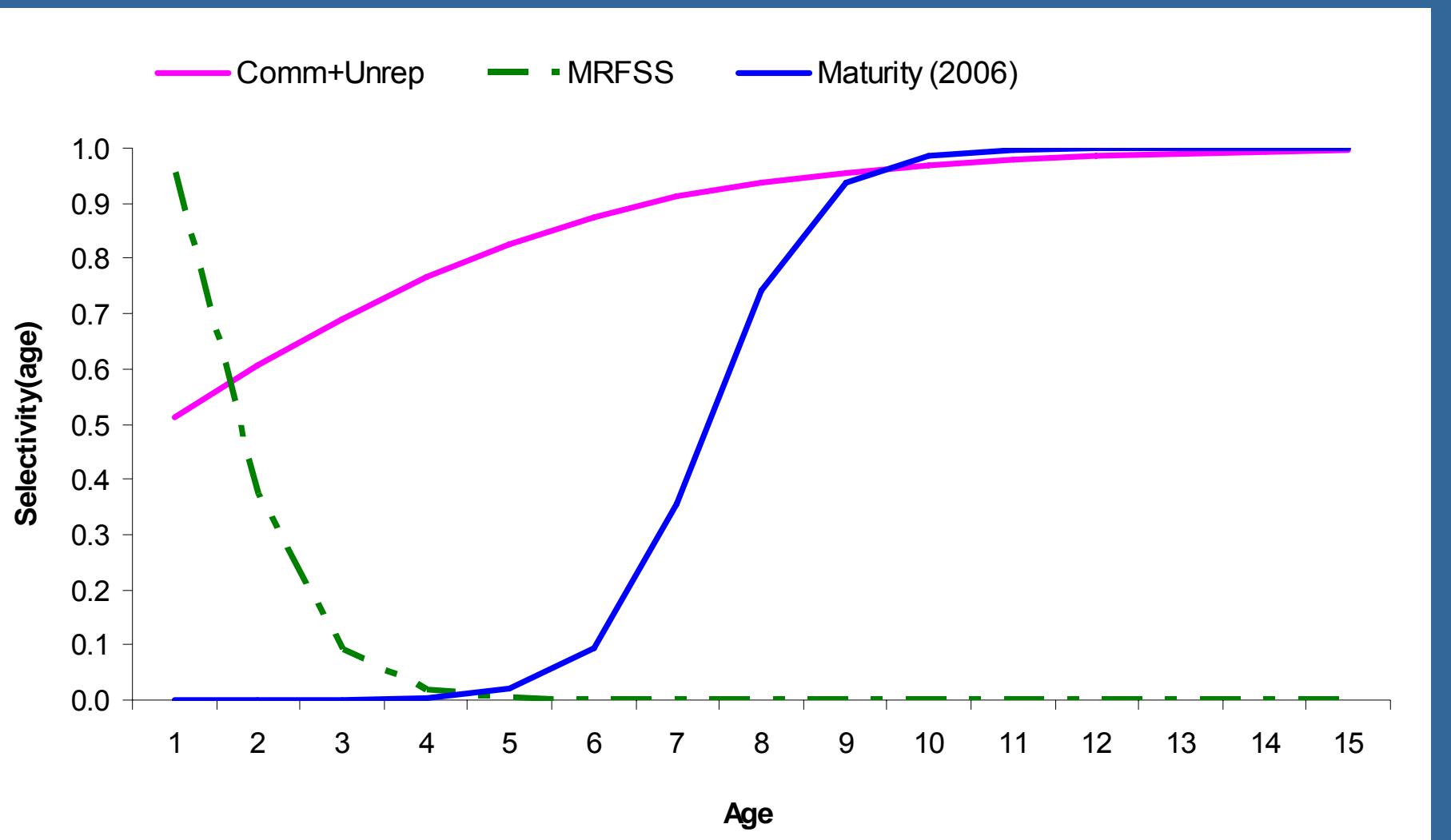


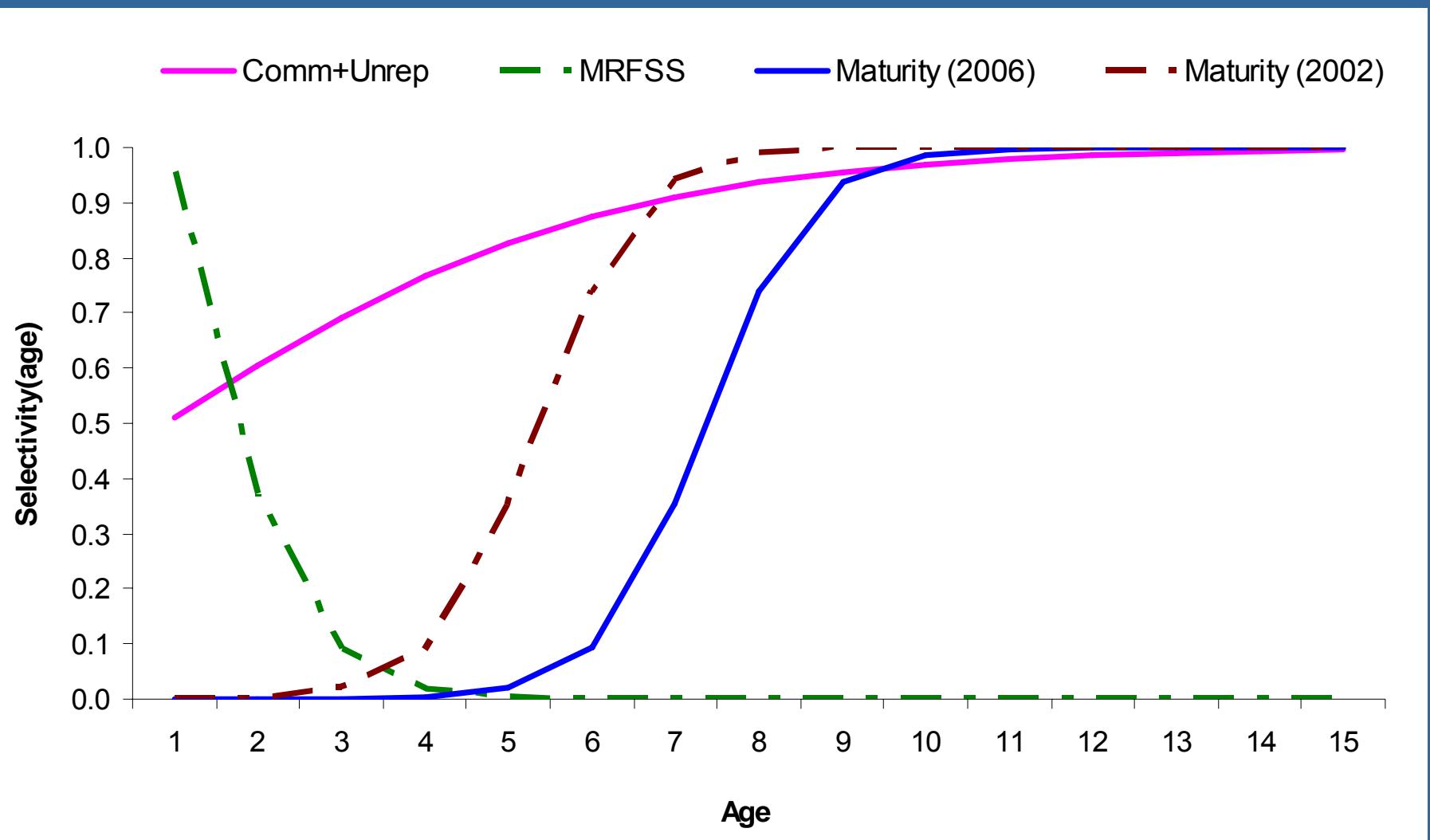


## Beverton-Holt



Steepness of 0.2-0.4 → factor of about 4 between survival at origin vs virgin





## 2. Model Description

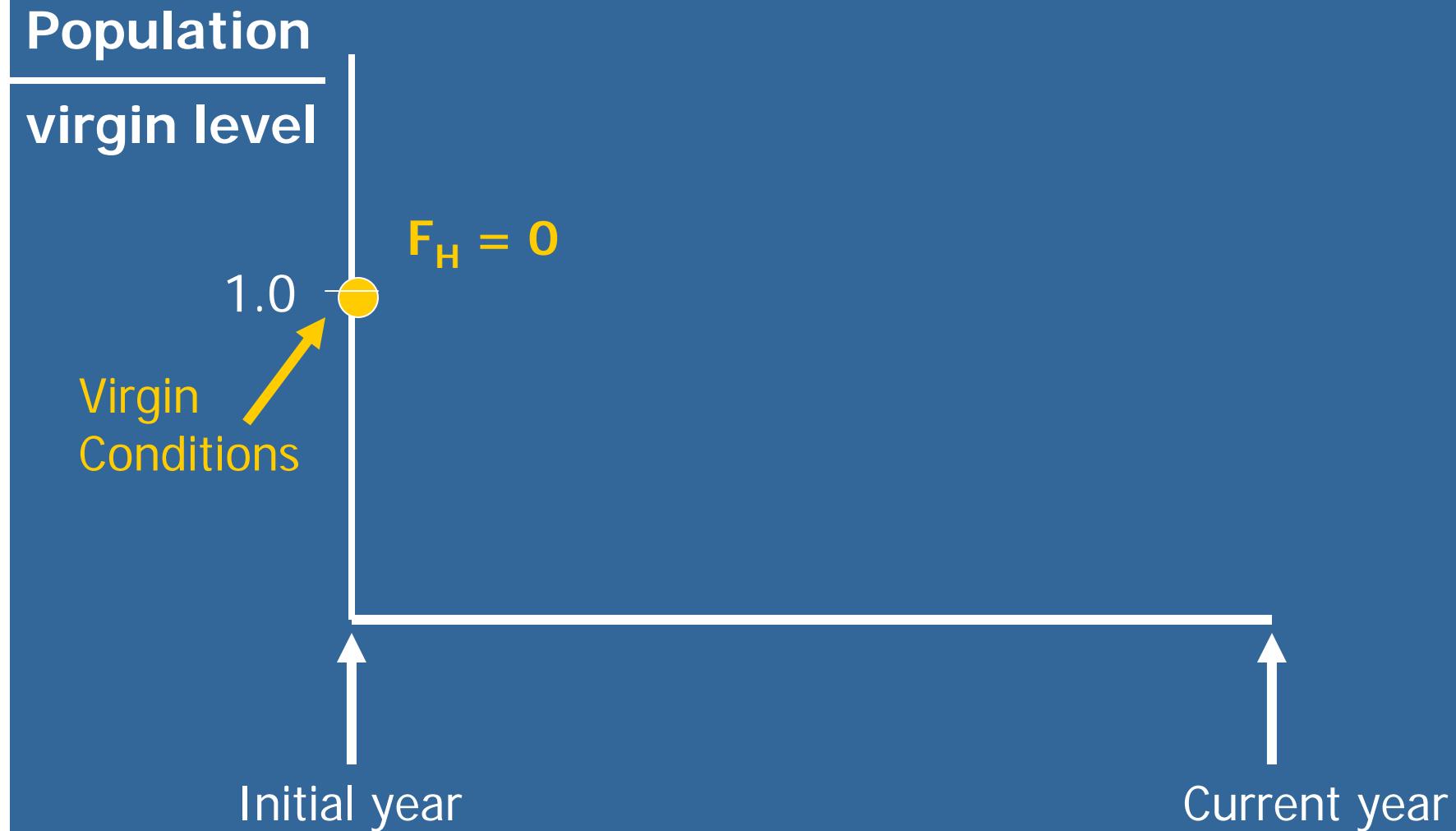
- State-space Age-structured Production model
- Process error in reproduction (pup-survival and virgin number pups), fishing effort
- Observation error in catches and indices
- Recruitment at age 1; ages 1-15 modeled, age 15 is a plus group

\*See pp135-138 for model equations

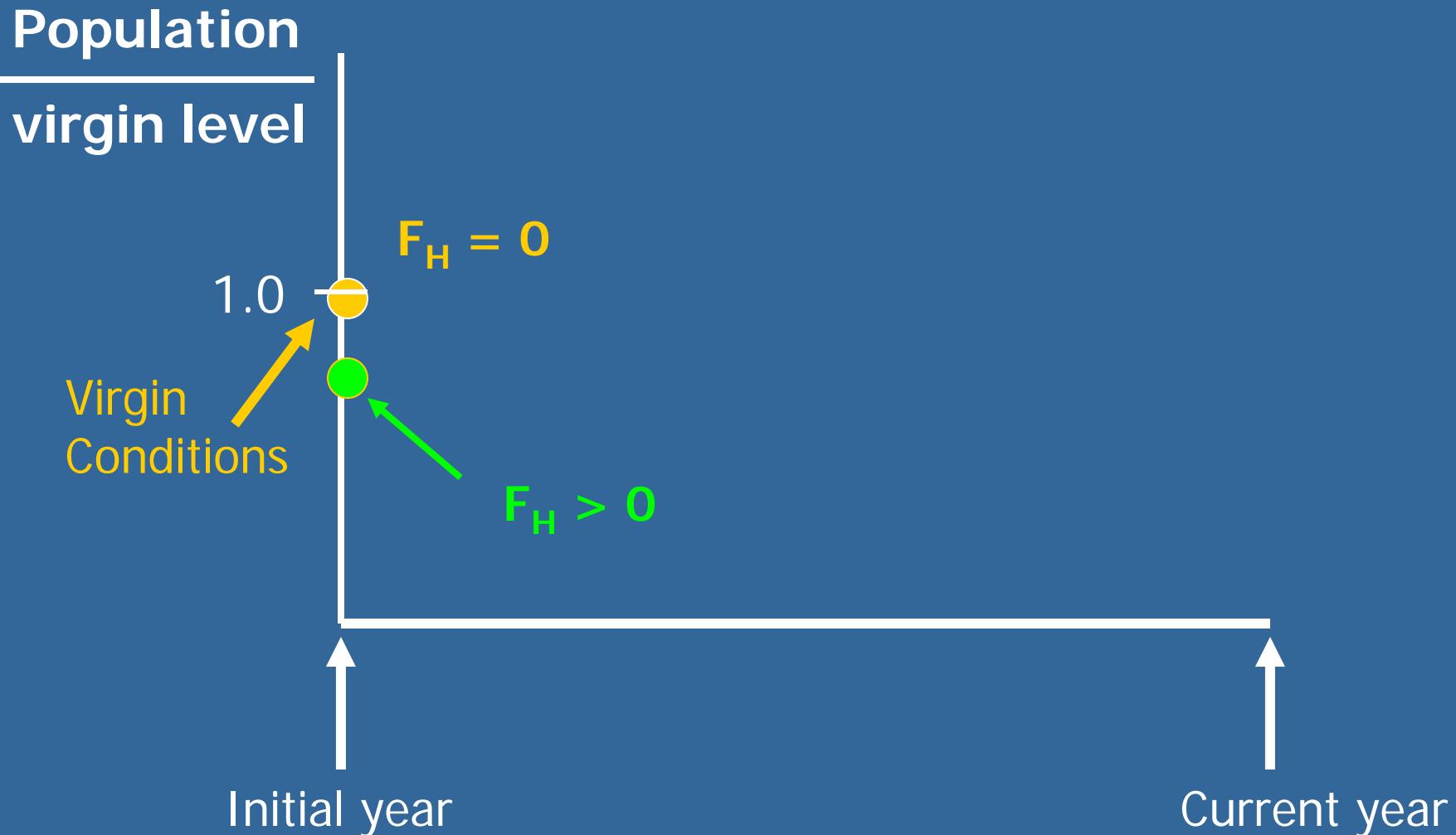
## 2. Model Description

- Initial population structure at equilibrium
- Option to estimate historic fishing level  $F_H$
- Fixing  $F_H=0$  forces virgin conditions at start of model

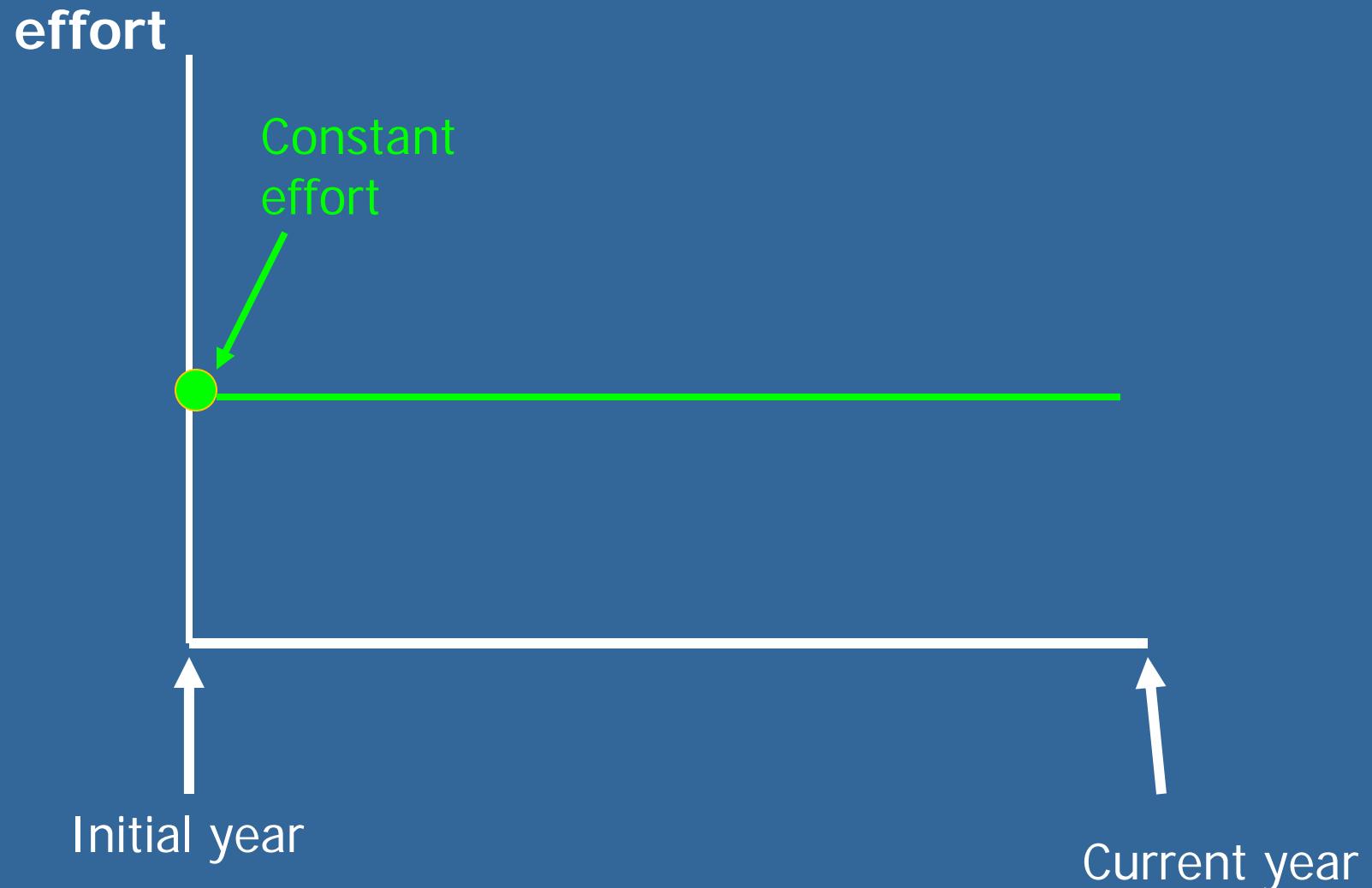
## 2. Model Description



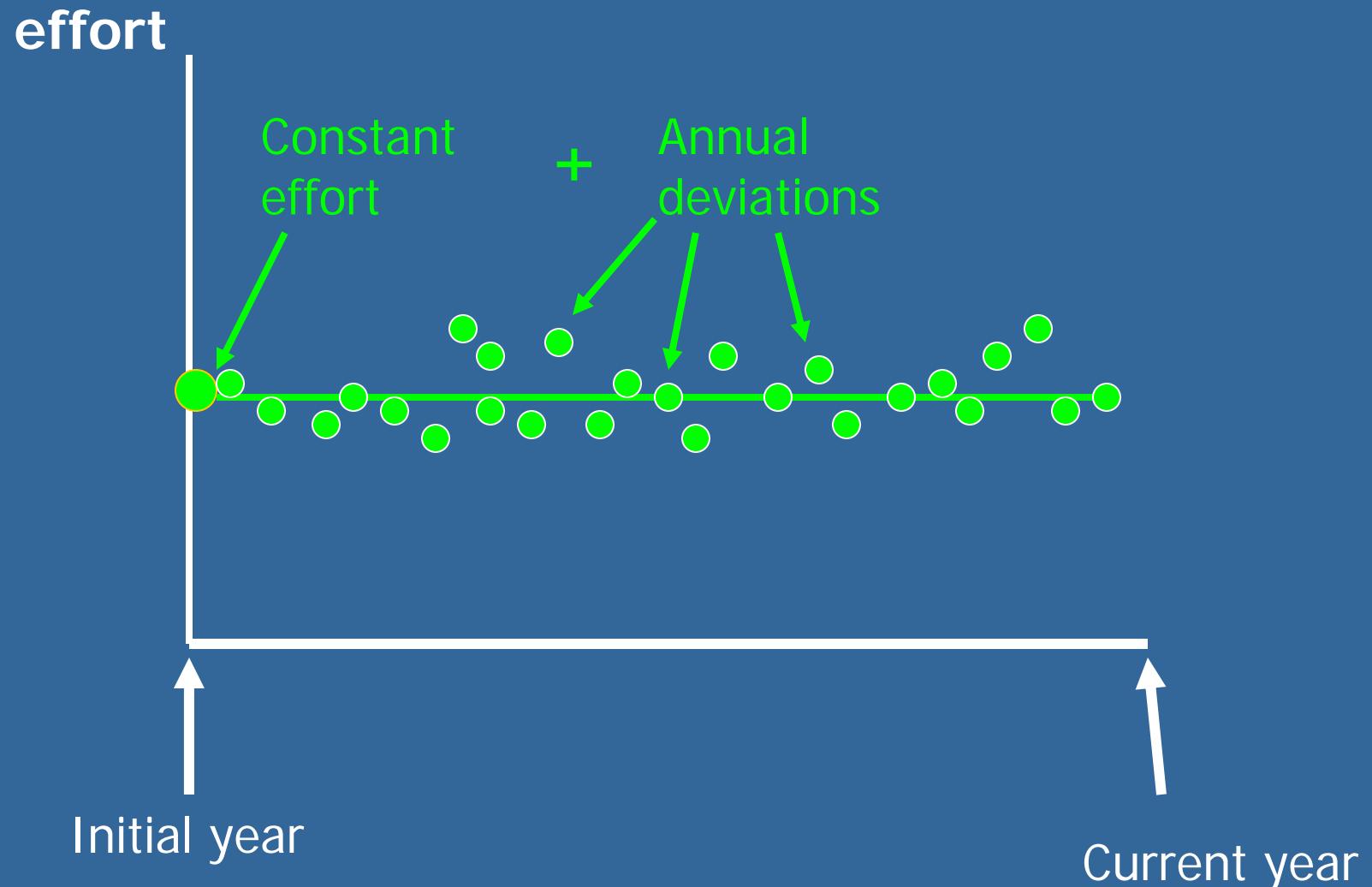
## 2. Model Description



## 2. Model Description



## 2. Model Description



## 2. Model Set-up

- Estimated catch series begin in 1981
- Earliest index (MRFSS\*) begins in 1981; earliest base index (Pelagic Logs) begins in 1992

\*MRFSS is a sensitivity index

### 3. Base Model and Results

- Virgin conditions: 1981 ( $F_H = 0$ )
- Updated biological parameters
- Base case indices (updated Pelagic LL)
- Catches “fit” 5 times “better” than indices

### 3. Base Model and Results

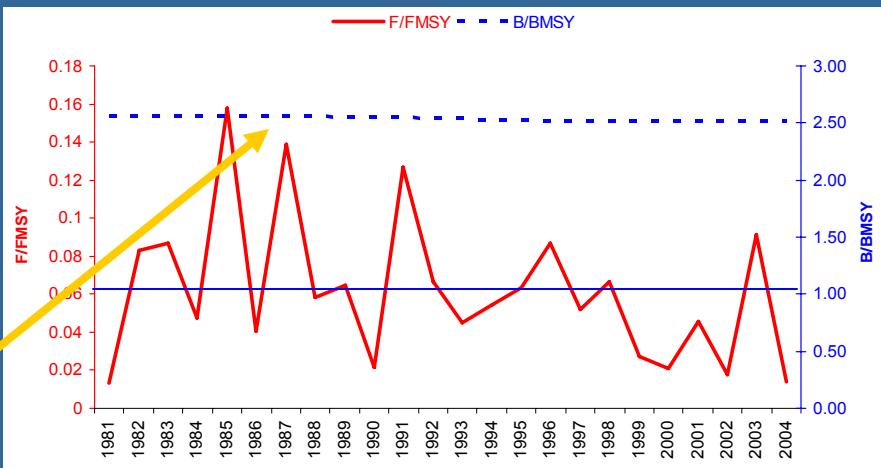
- $\text{SSF}_{2004}/\text{SSF}_{\text{MSY}} = 2.51 \rightarrow \text{NOT overfished}$
- $F_{2004}/F_{\text{MSY}} = 0.01 \rightarrow \text{NO overfishing}$
- Steepness = 0.38
- $\text{SPR}_{\text{MSY}} = 0.62$
- $F_{\text{MSY}} = 0.20$

# Fig 6.5

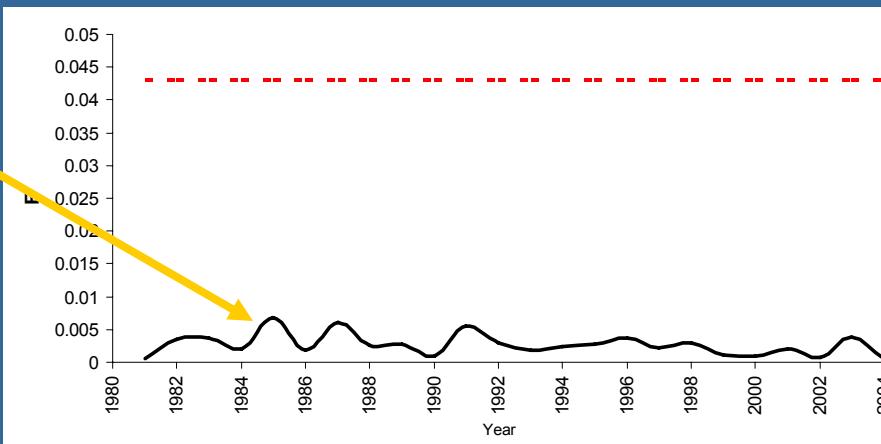
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$F/F_{MSY}$  and  $B/B_{MSY}$

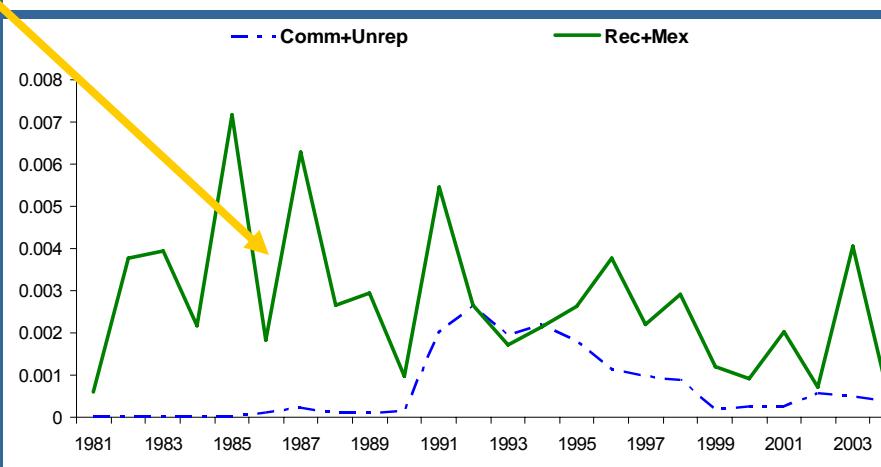
No impact  
from catches



Very small  
 $F$  values



Total  $F$  and  $F_{MSY}$

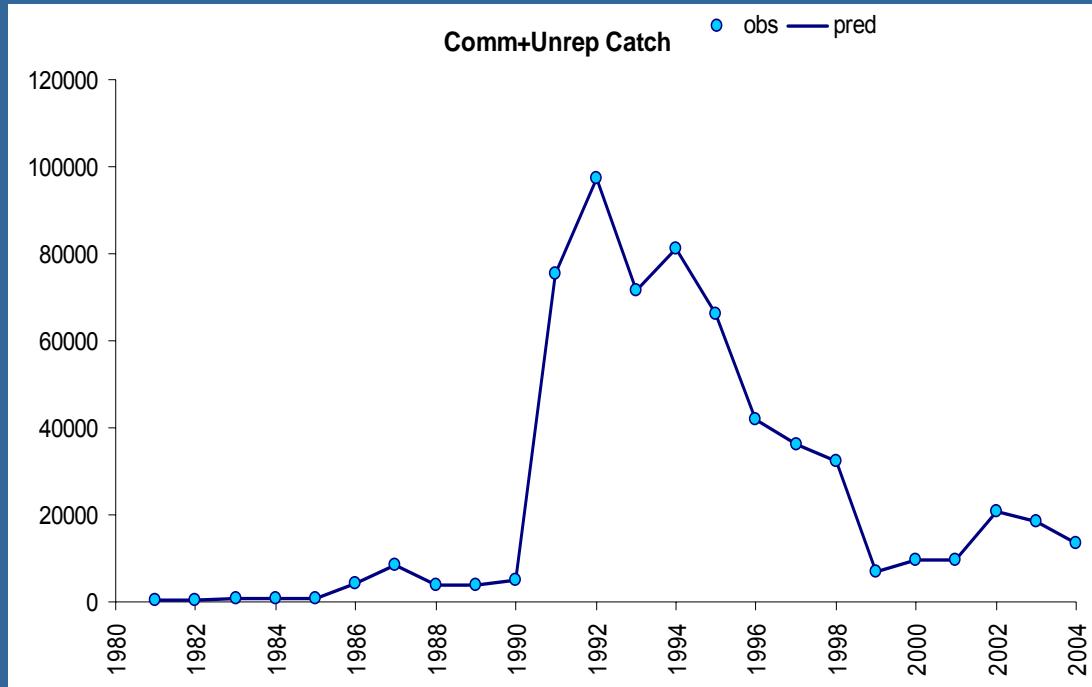


$F$  by fleet

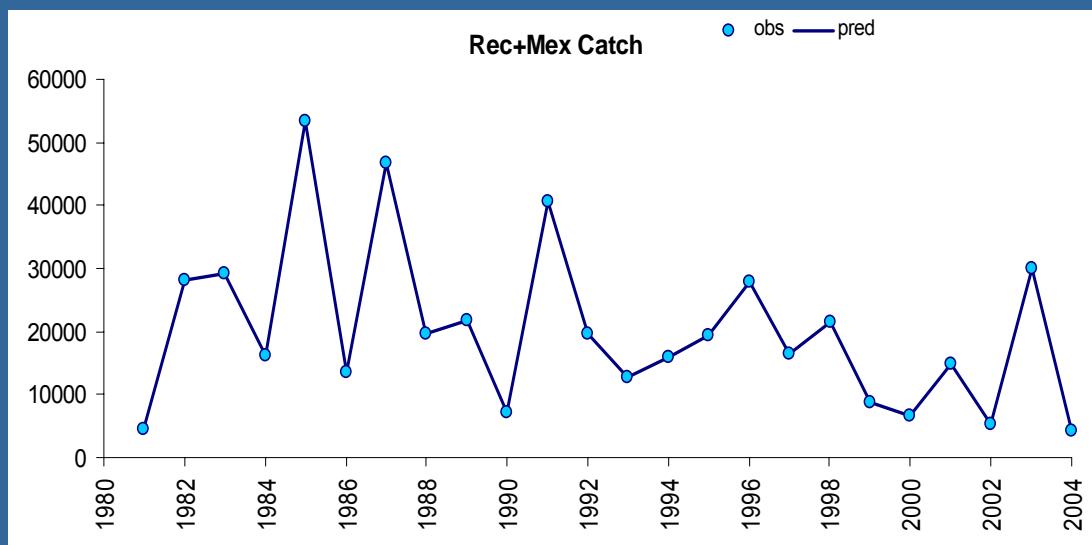
# CATCHES

Fig 6.7

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Commercial +  
Unreported



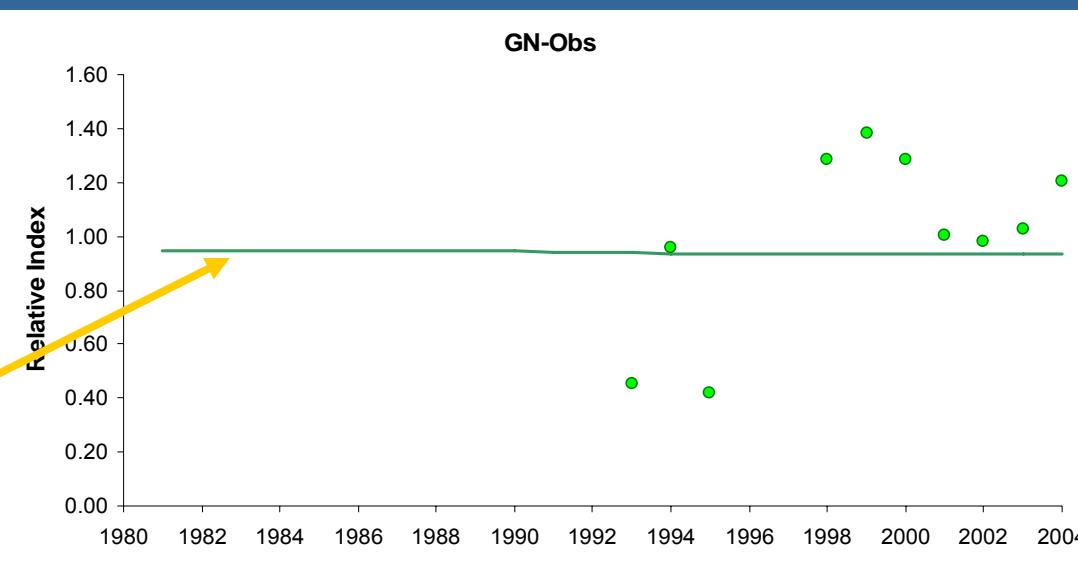
Recreational

# INDICES

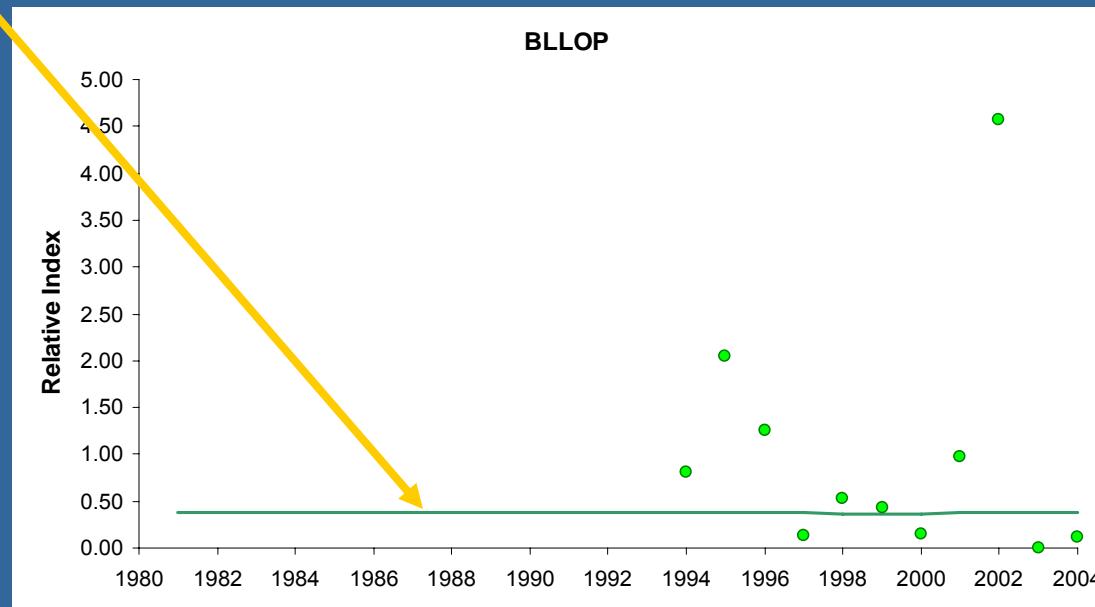
Fig 6.8

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No impact  
from catches



GN Observers



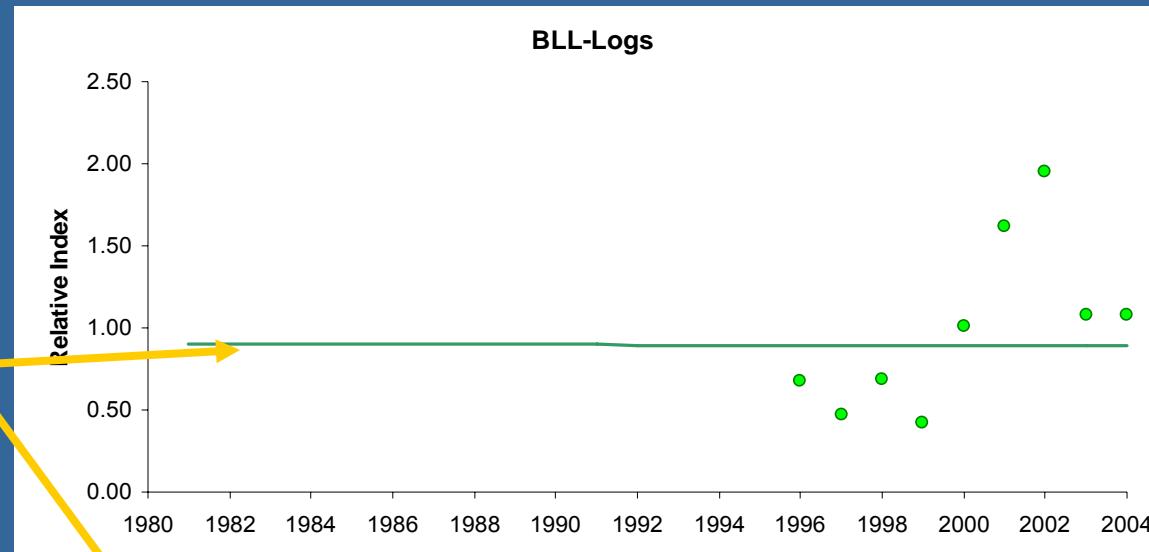
BLLOP

# INDICES

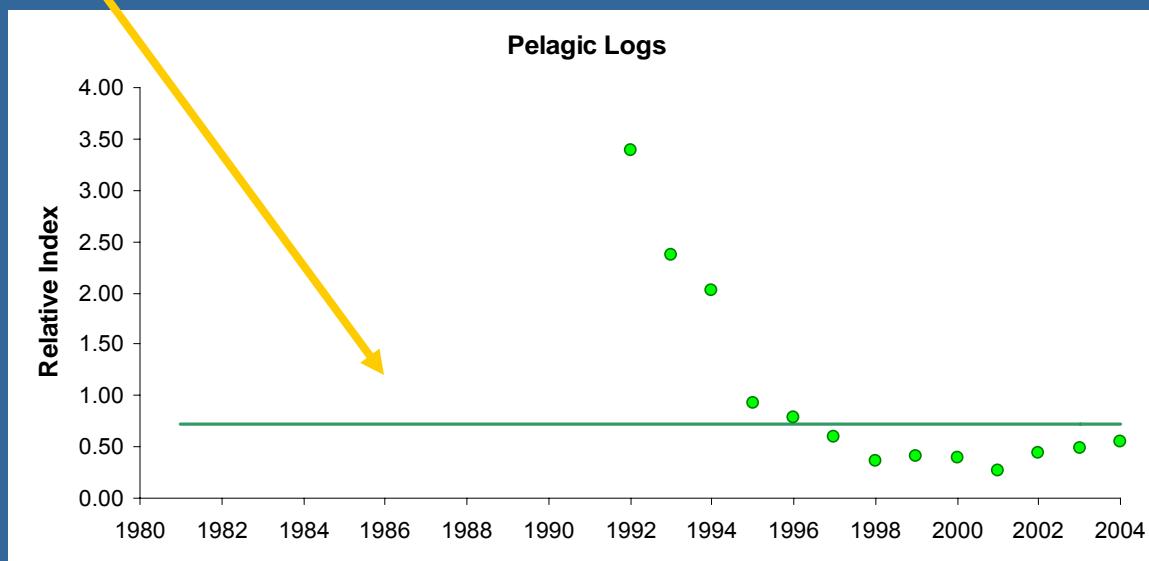
Fig 6.8

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No impact  
from catches



BLL Logs



Pelagic Logs

### 3. Base Model and Results

- No Projections Performed
- Estimated status from all models considered at AW ranged from overfished and overfishing, to not overfished and no overfishing
- Short time series of indices, conflicting trend in indices with same selectivity, lack of historical perspective, reasons for AW consensus that stock status could not be determined

## 4. Sensitivity Analyses

- None performed

# 5. Summary of Base Results

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Parameter	Base	
	Est	CV
AICc	-99.96	
Obj. Fn	-2.51E+02	
MSY (kg)	1.49E+07	--
Pups-virgin	6.27E+06	0.53
SSF2004	1.82E+07	0.54
Nmature2004	1.09E+07	0.54
B2004	1.23E+09	0.54
<b>B2004/B-virgin</b>	<b>0.89</b>	0.01
SSF2004/SSF-virgin	0.94	0.01
Nmature2004/Nmature-virgin	0.90	0.01
<b>SSF2004/SSFMSY</b>	<b>2.51</b>	0.32
SPRMSY	0.62	--
F2004	0.001	0.53
FMSY	0.20	--
<b>F2004/FMSY</b>	<b>0.01</b>	0.53
Pup-survival	0.82	0.29
alpha	2.41	--
steepness	0.38	--

# 6. Continuity

- (already discussed for BT Gulf)

